We want to know how the magnetic field of the pair spectrometer magnet influences the functionality of the photomultiplier tubes. To test this, two tests were done. The first series of tests was to see how the output of the pmt changed as the pmt was brought closer to the magnet with and without the pmt protected by mu metal. This test only measured the signals from the background. The second series of tests we placed a Cesium button source close to the scintillator and repeated the first series of tests.

The first test, using background, the output of the pmt was measured as a function of distance from the pair spectrometer magnet. A Photonis pmt and divider was used, set at 1200 Volts, and a 14.5 mV threshold. First, no mu metal was around the pmt. The results are listed below.

Distance from magnet	**Counts**		
(cm)	***(cts/2 min)***	***(cts/2min)***	***Avg cts/min***
76	1022	n/a	511
68	912	890	450.5
58	664	654	329.5
50	396	422	204.5
40	249	223	118
35	150	182	83
30	43	65	27
28	17	9	6.5
25	0	1	0.5
20	0	0	0

Table 1: Data found using Photonis equipment with no mu metal and no source present.

Next, the pmt was covered by a cylinder of mu metal and the test was rerun. The results are listed in below in Table 2.

Distance from magnet	**Counts**		
(cm)	***(cts/2 min)***	***(cts/2min)***	***Avg cts/min***
76	1233	1287	630
68	1139	1284	605.75
58	1331	1283	653.5
50	1282	1206	622
40	1277	1251	632
35	1182	1156	584.5
30	1258	1305	640.75
28	1315	1327	660.5
25	1306	1281	646.75
20	1396	1353	687.25
15	1620	1530	787.5
10	2739	2672	1352.75
5	130	146	69
4	51	50	25.25
3	19	28	11.75
2	15	7	5.5

Table 2: Data found using Photonis equipment with cylinder of mu metal protecting the pmt.

Then, the cylinder of mu metal was wrapped in a couple sheets of mu metal for additional protection and placed over the pmt. The test was once again rerun and the data found is listed in Table 3.

Distance from magnet	Counts		
(cm)	*(cts/2 min)*	*(cts/2min)*	*Avg cts/min*
76	380	406	196.5
68	373	382	188.75
58	408	349	189.25
50	423	382	201.25
40	375	384	189.75
35	403	416	204.75
30	385	356	185.25
25	382	388	192.5
20	412	393	201.25
15	432	412	211
10	377	386	190.75
5	226	222	112
4	111	118	57.25
3	43	53	24
2	19	26	11.25

Table 3: Data found using Photonis equipment with cylinder of mu metal wrapped in a sheets of mu metal protecting the pmt.

All of the data for this series of tests is compared in Figure 1.

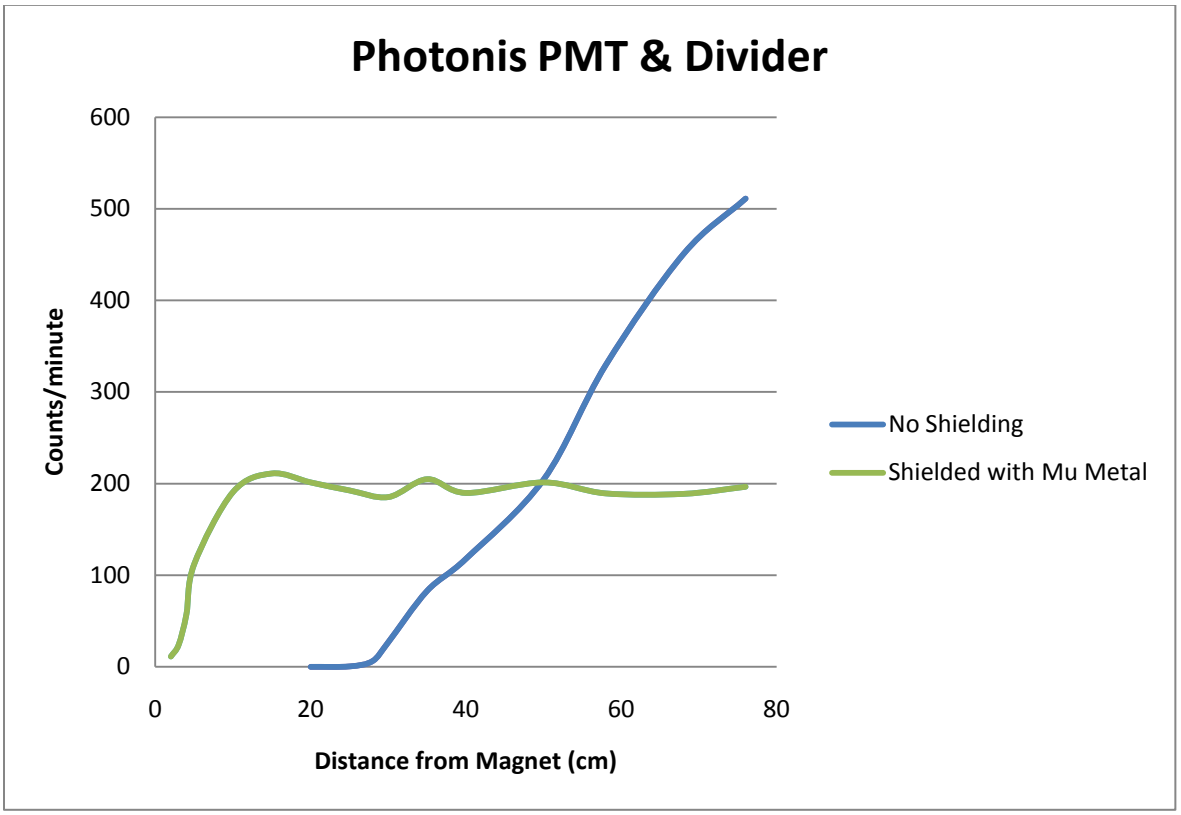

Figure 1: A plot of the results of the test using only background counts and using a Photonis PMT and divider.

The second series of tests were performed using a PMT and divider made by Hamamatsu. The voltage was set at 1200 Volts and a threshold of 600 mV was used. A Cs-137 button source was placed on the scintillator. The data acquired for the test ran without the mu metal protecting the PMT is listed below.

Distance from magnet	Counts		
(cm)	*(cts/min)*	*(cts/min)*	*Avg cts/min*
80	22895	22457	22676
70	22911	23122	23016.5
60	23269	23153	23211
50	22776	22883	22829.5
40	17892	18242	18067
35	4566	4805	4685.5
30	36	34	35
25	1	6	3.5
20	2	0	1

Table 4: Data found using a Hamamatsu PMT and divider in the presence of a Cs source, no mu metal.

Next, we covered the PMT with a cylinder and a couple sheets of mu metal. The results are listed below.

Distance from magnet	Counts		
(cm)	*(cts/min)*	*(cts/min)*	*Avg cts/min*
80	23746	23857	23801.5
70	23635	23468	23551.5
60	23548	23590	23569
50	23444	23721	23582.5
40	23661	23357	23509
30	23449	23489	23469
20	23546	23663	23604.5
10	23403	23295	23349
5	23605	23564	23584.5
2	23593	23330	23461.5

Table 5: Data found using a Hamamatsu PMT (covered with mu metal) and divider in the presence of a Cs source.

The results are compared in Figure 2.

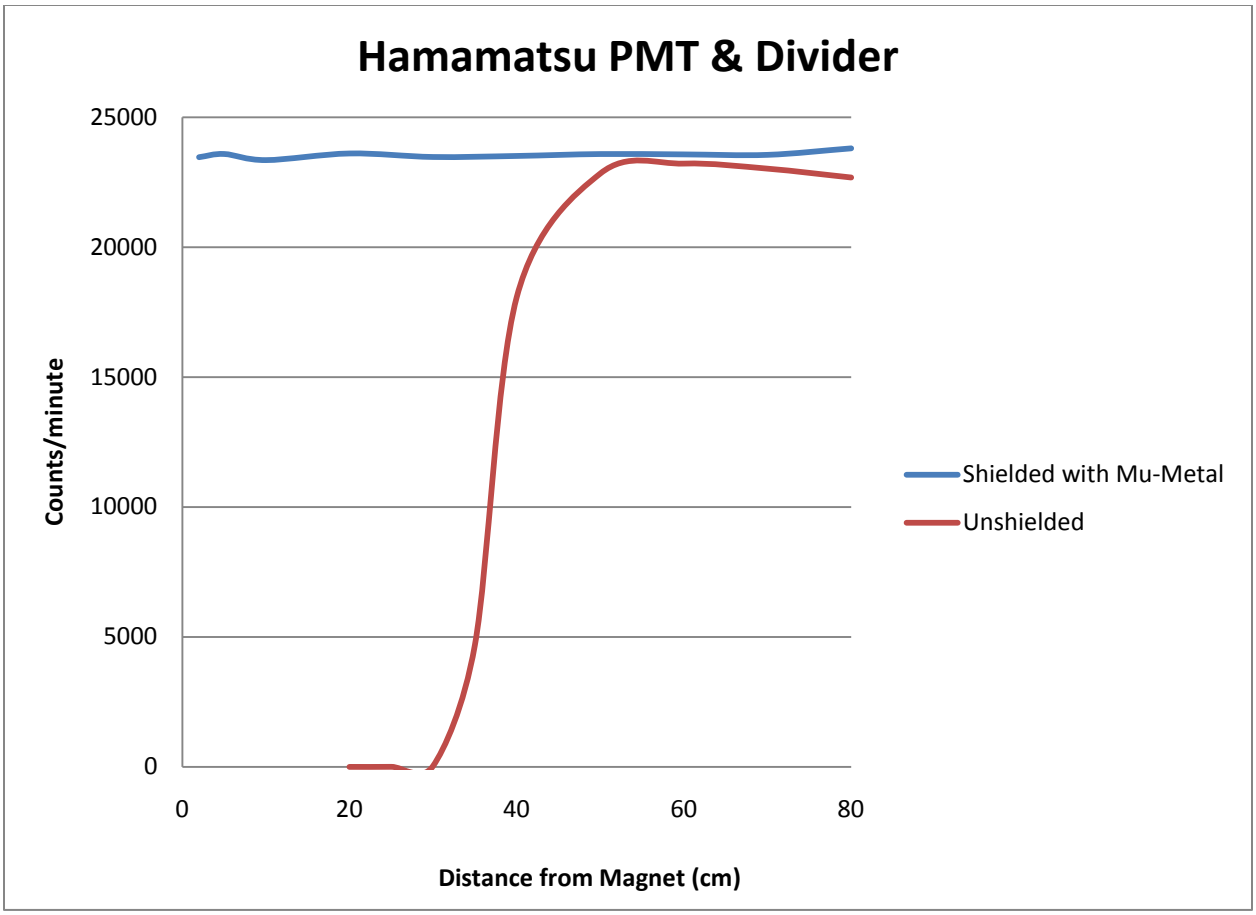

Figure 2: Output from a Hamamatsu PMT and divider in the presence of a Cs-137 button source as a function of distance from the pair spectrometer magnet with and without mu metal protection.

As can be seen from the data above, the mu metal plays an important role in the functionality of the PMT when operating in a magnetic field. Using the Hamamatsu PMT and divider, we were able to place the detector up against the pair spectrometer magnet without affecting the output as long as the PMT was covered in mu metal.